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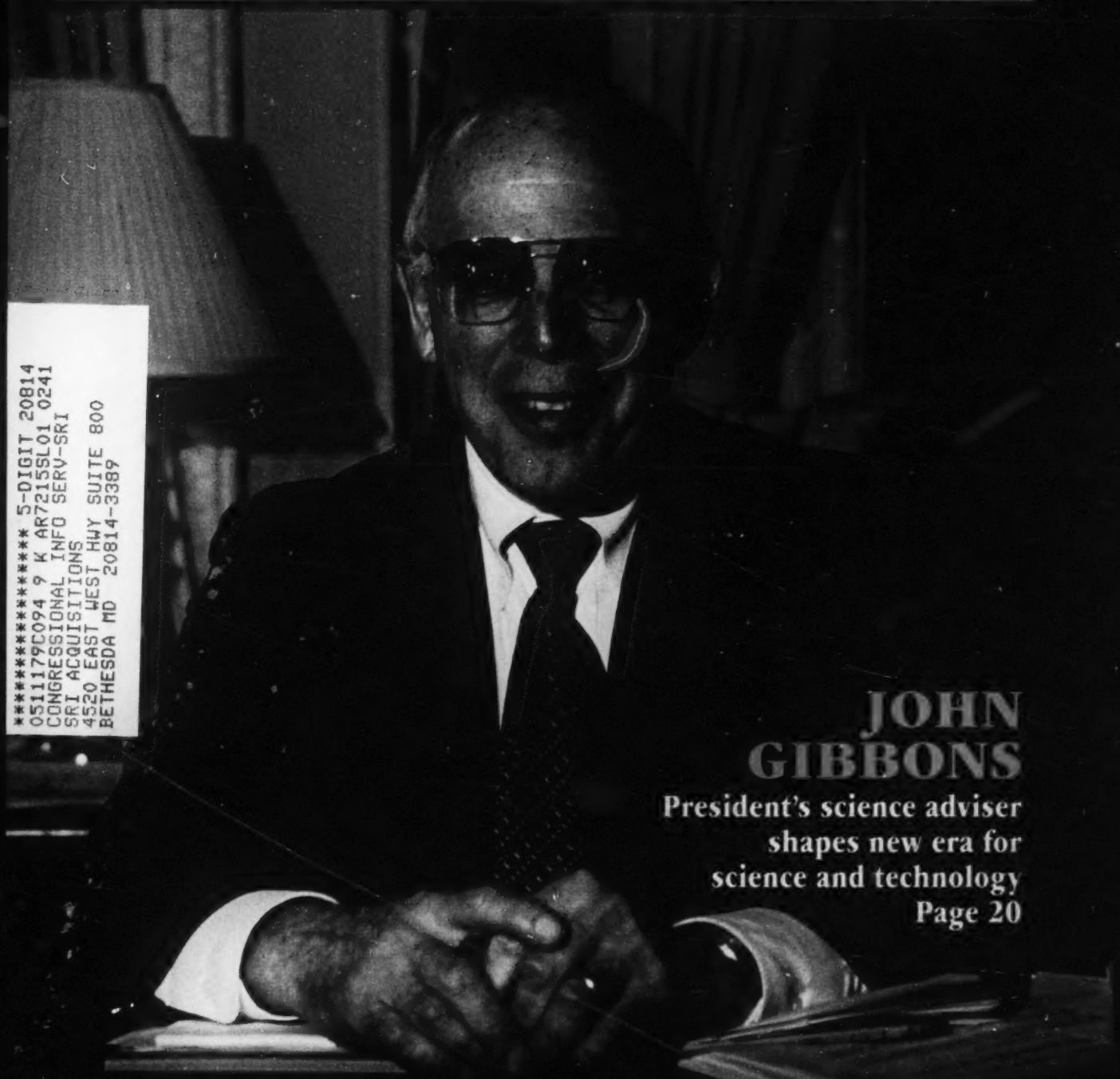
CHEMICAL & ENGINEERING NEWS

C&EN

APRIL 11, 1994

TOP 50 CHEMICAL PRODUCTS IN U.S. GROW MODESTLY IN 1993 **PAGE 12**



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JOHN GIBBONS

President's science adviser shapes new era for science and technology

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CHEMICAL & ENGINEERING NEWS

C&EN

APRIL 11, 1994

NEWS OF THE WEEK

■ Natural gas in geologic deposits may have been produced by catalytic influences of sedimentary rock on kerogen rather than by thermal decomposition of organic matter. **Page 4**

■ Isotopic tests indicate North Korea may have produced much more plutonium than it admits, says the International Atomic Energy Agency. **Page 5**

■ Coverup by a tobacco company of a study that indicates nicotine is addictive—at least in rats—is charged by chairman of House panel examining possible regulation of cigarettes. **Page 6**

■ Chemical stocks were affected by the stock market plunge of the past two weeks, and their prices fell significantly. **Page 6**

■ U.K.'s Courtaulds and Germany's Hoechst have completed the merger of their viscose rayon and acrylic fibers operations in Europe, forming the second largest European producer of cellulosic fibers. **Page 7**

■ Clearer rules, a two-stage review system, and public explanation of decision-making are some of the key recommendations of a study of NSF's major grant-awarding process. **Page 7**

COVER: Photo by C&EN's David J. Hanson

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BUSINESS

Production of C&EN's Top 50 chemicals increased moderately in 1993, paced by organics, which were up nearly 10%; output of inorganics, however, slipped almost 1%. **Page 12**

Polymers production increased nearly 3% last year, reaching a new high of 67.4 billion lb. **Page 15**

European chemical industry had higher sales and earnings than expected last year, with the notable exception of petrochemicals; outlook for 1994 is brighter. **Page 17**

SCIENCE/TECHNOLOGY

Computer-aided molecular design is evolving to satisfy customer needs as molecular modeling and computational chemistry bid to become mainstream activities. **Page 31**

BOOKS

"Nobel Prize Women in Science: Their Lives, Struggles and Momentous Discoveries" provides an eye-opening look at 14 brilliant scientists and the barriers they faced. **Page 41**

ACS NEWS

Investigations of six mass firings of chemical professionals have been completed, indicate that employment picture is worse for older, experienced workers. **Page 45**

ACS Lehigh Valley Section celebrates its 100th anniversary with a full day of activities. **Page 47**

MEETINGS

Program of ACS Joint 26th Central & 27th Great Lakes Regional Meeting features nearly 600 papers and a special program for undergraduate students. **Page 51**

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After a little more than a year as the President's science adviser, John Gibbons talks about his work, changing national and international science policy, and what it's like to work in the Clinton White House. Page 20

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LETTERS

Bromine, biomass burning

In the report by S. Manö and M. O. Andreae [*Science*, **263**, 1255 (1994)] and the accompanying perspective by R. J. Cicerone [*Science*, **263**, 1243 (1994)] on the emission of methyl bromide from burning biomass, the role of the heat and smoke plume in getting this source of methyl bromide to the stratosphere is not mentioned. The rapidly rising plumes carrying it and other halogenated organics may well make such burnings the source of over 90% of the bromine in the stratosphere and of a much larger percentage of the chlorine than is currently accepted. In addition, the mass of materials in the smoke will greatly reduce photochemical reactions that destroy many halogenated compounds released by people or the oceans.

In the case of pesticide use, Cicerone indicates that the global release of methyl bromide is based on all of the used chemical escaping to the atmosphere. With grain fumigation, reactions altering essential biochemicals have been known for some years [*J. Sci. Food Agric.*, **6**, 269 (1955) and cited papers; *J. AOAC*, **72**, 815 (1989)]. Similar reactions probably occur to some extent in soils, so the initial contribution to the atmosphere from pesticide use may be quite a bit lower than the value cited by Cicerone.

Consequently, this newly discovered source of methyl bromide emission appears to be the one that needs much more control than the other emissions. And a major confirmation of the role of this emission has evolved these past few months as a result of the huge fires in Australia and Ethiopia. The upcoming ozone hole measurements ought to show some very significant shifts indicating that major programs to stop biomass burning are needed as the key step to stop ozone losses in the stratosphere.

James A. Singmaster III
Fremont, Calif.

More on Nobel Laureates

In his review of "Nobel Laureates in Chemistry 1901–1992" (C&EN, Feb. 14, page 32), George B. Kauffman ignores the fact that numerous chemists have been honored by the award of the Nobel Prize in Physiology or Medicine for studies in chemistry. His conclusions on such topics as the types of chemists who win the award during a given historical period, or when the last woman chemist won the prize, are not correct when considered in this context.

Work in medicinal chemistry and in the chemistry of natural products is as likely to be recognized for its importance to medicine or physiology as it is for its importance to chemistry. Examples include the medicine or physiology award to chemists like Paul Ehrlich, the father of medicinal chemistry (1908); Gerhard Domagk (sulfonamides, 1939); Edward A. Doisy (steroids, 1943); Edward C. Kendall and Tadeus Reichstein (corticoids, 1950); Daniel Bovet (antihistamines, 1957); Konrad Bloch and Feodor Lynen (steroid biosynthesis, 1964); and Roger Charles L. Guillemin and Andrew V. Schally (peptide hormones, 1977). Six years ago, Gertrude B. Elion and George H. Hitchings were awarded the prize (1988) for their design, synthesis, and studies of antineoplastic and antiviral drugs.

But Victor J. Linnenbom's letter (C&EN, March 28, page 3) commenting on Kauffman's review in which Linnenbom asserts that "merit [is] the sole criterion in selecting the laureates" must have been written in a parallel universe. One obvious additional criterion is that the recipient has to be alive. Given the fact that the prize is sometimes not awarded until decades after a discovery, it is possible for a deserving would-be laureate to die before he or she can be recognized. And like many human institutions, the Nobel Prize is subject to internal and external political pressures. Domagk was actually forced to decline the prize by the Nazis in 1939, but received a gold medal in lieu of the prize money in 1947. Robert B. Woodward did not receive the prize until 1965, following the death of another laureate who opposed the award to Woodward. And lastly, anyone who does not believe that women in science face greater obstacles to success than men should read Gertrude Elion's autobiographical essay in *Annual Reviews of Pharmacology* (1993).

Manfred E. Wolff
Senior Vice President, R&D
ImmunoPharmaceutics Inc.
San Diego

Correction

• March 28, page 37: Howard E. Simmons III should have been identified as a research associate at DuPont not as emeritus vice president for research, his recently retired father.

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Top 50 Chemicals Production Rose Modestly Last Year

■ ***Output rose nearly 3% in 1993; organics set the pace, up nearly 10%, while inorganics declined almost 1%***

Marc S. Reisch,
C&EN Northeast News Bureau

Production of the 50 largest volume chemicals rose modestly in 1993 following a fairly substantial increase in output in 1992. Chemical industry economists and observers attribute the increase to fairly strong U.S. markets, as the pace of U.S. economic expansion continued to quicken.

According to C&EN's annual ranking of the Top 50 chemical products, total production of the group rose to nearly 685 billion lb last year, up almost 3% from 1992. That increase followed a 5% gain in production of the Top 50 chemicals in 1992.

In 1992, the U.S. economy—and Top 50 chemical production—got stronger as both shrugged off the effects of the 1991 recession. The reawakening economy, combined with continued strong exports, helped considerably to boost chemical output in 1992. But in 1993, points out DuPont chief economist Richard A. Stuckey, chemical exports were fairly flat. Western Europe, a large customer of U.S. chemicals, was mired in a recession, thus cutting demand for all types of U.S. products.

Stuckey says U.S. chemical production benefited in 1993 particularly because of increased demand from motor vehicle, housing, and home furnishings customers. As consumer interest rates reached their lowest point in years, buyers, who earlier could not afford new cars or homes because of high interest rates, were back in the market, he explains. Motor vehicle production climbed and with it rose demand for the plastics and rubber components fashioned from chemical intermediates. Housing starts also increased, and along with them came an increase in demand for adhesives and plastics produced with materials the U.S. chemical industry supplies. To furnish those new homes, consumer demand rose for such items as nylon carpet and olefin upholstery—all produced from U.S. chemical products.

"Clearly, strong housing and automotive industries were important to the growth of industrial shipments in 1993," concurs Allen J. Lenz, the Chemical Manufacturers Association (CMA) director of trade and economics. Export markets were weak, he also says. Had those markets been stronger in 1993, they would

About the Top 50 list of chemical products

Government data, trade association figures, and industry estimates all go into preparing C&EN's annual list of the Top 50 chemical products in the U.S., ranked by production volume. The federal government is relied upon most heavily, but when government figures are not available, other sources, primarily trade associations, are used. Industry sources and C&EN estimates are used only when other data are lacking.

Government data are not always accurate—they are only as good as the information that individual companies report. But they are an objective measure of production extending back many years. Therefore, relatively accurate indications of growth can be made on a consistent basis.

At this time of year, C&EN has access only to preliminary reports of production for 1993. When the government and trade associations issue their final reports, the outcome can change, sometimes dramatically. As a result, the production figures, as well as rankings, for earlier years that appear in the table on page 13 are different in some cases from those published in last year's Top 50 article (C&EN, April 12, 1993, page 11). In this year's compilation, the 1992 ranking of 17 chemicals is different from the 1992 ranking published last year.

The list itself covers production figures for the U.S. and includes chemicals produced for export. Candidates for the list include all basic, intermediate, and chemically homogeneous finished products. These range from chemical building blocks like ethylene and propylene to downstream products like vinyl acetate and ethylene glycol.

The roster includes basic inorganic chemicals, but does not include what C&EN considers to be minerals, such as salt, gypsum, and sulfur. Lime is included because it is processed and has many chemical and industrial applications. Refractory (dead burned) dolomite is excluded in lime production.

In the organics list, petrochemical feedstocks such as ethane, butane, and propane are excluded arbitrarily because they are considered to be products of oil companies and because they have many nonchemical uses.

There are other gray areas besides lime and petrochemical feedstocks. For example, the basic aromatics—benzene, toluene, and xylene—are included.

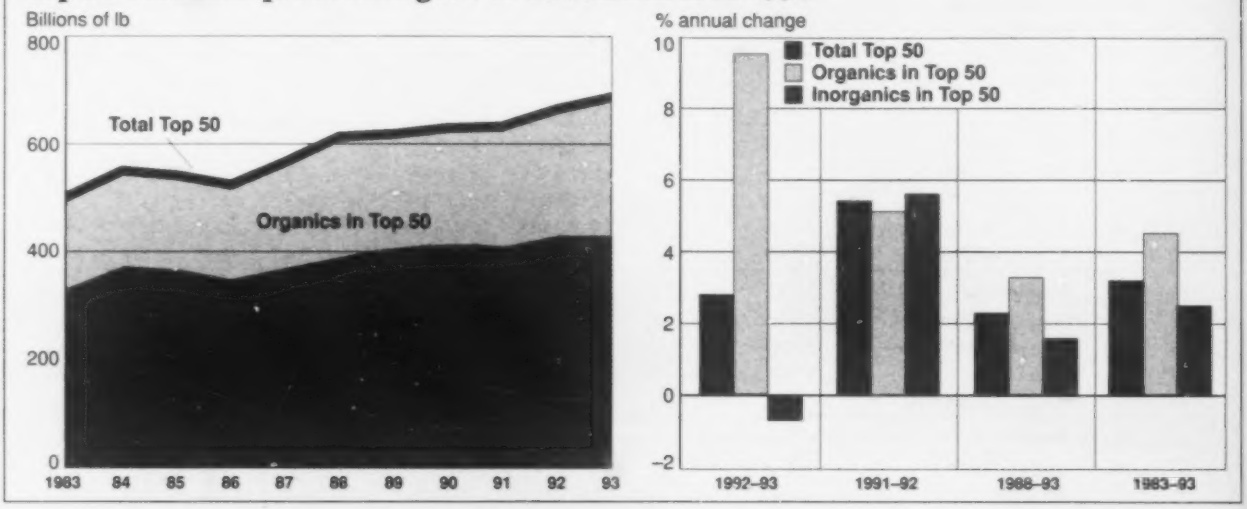
Production figures are published by the government in a variety of units—pounds, tons, cubic feet, gallons, metric tons, and, most recently, kilograms and liters. Where the latter two units are used, they have been converted, where appropriate, into the common units historically used as points of reference. To provide an accurate ranking and to make comparison of production volumes easier, C&EN lists production not only in common units, but also converted to pounds.

Organics led last year's Top 50 chemicals production increase

Rank 1993	Rank 1992[a]		Billions of lb 1993	Billions of lb 1992	Common units[b] 1993	Common units[b] 1992	Average annual change 1992–93	Average annual change 1991–92	Average annual change 1988–93	Average annual change 1983–93
1	1	Sulfuric acid	80.31	89.72	40,153 tt	44,860 tt	−10.5%	3.5%	−1.2%	0.7%
2	2	Nitrogen	65.29	60.51	901 bcf	835 bcf	7.9	10.0	4.5	4.9
3	3	Oxygen	46.52	43.46	562 bcf	525 bcf	7.0	11.2	4.5	5.0
4	4	Ethylene	41.25	40.93	41,251 mp	40,931 mp	0.8	2.4	2.1	3.7
5	6	Lime[c]	36.80	35.71	18,400 tt	17,857 tt	3.0	3.4	2.1	2.2
6	5	Ammonia	34.50	36.59	17,252 tt	18,295 tt	−5.7	6.6	0.5	2.1
7	8	Sodium hydroxide	25.71	24.50	12,854 tt	12,249 tt	4.9	4.6	4.1	2.3
8	9	Chlorine	24.06	23.51	12,028 tt	11,757 tt	2.3	2.9	1.3	1.9
9	19	Methyl *tert*-butyl ether	24.05	10.88	24,053 mp	10,877 mp	121.1	13.7	33.5	39.9
10	7	Phosphoric acid	23.04	25.58	11,521 tt	12,792 tt	−9.9	6.1	−0.2	1.7
11	10	Propylene	22.40	23.43	22,403 mp	23,426 mp	−4.4	8.7	1.1	4.8
12	11	Sodium carbonate[d]	19.80	20.84	9,899 tt	10,419 tt	−5.0	4.9	0.5	1.6
13	15	Ethylene dichloride	17.95	15.15	17,949 mp	15,153 mp	18.5	10.5	6.6	4.5
14	13	Nitric acid	17.07	16.09	8,537 tt	8,043 tt	6.1	1.5	1.3	2.1
15	14	Ammonium nitrate[e]	16.79	15.66	8,394 tt	7,832 tt	7.2	0.7	2.3	3.0
16	12	Urea[f]	15.66	17.96	7,832 tt	8,981 tt	−12.8	10.4	−0.2	2.7
17	16	Vinyl chloride	13.75	11.31	13,748 mp	11,309 mp	21.6	−3.3	8.7	7.2
18	17	Benzene	12.32	11.27	1,672 mg	1,530 mg	9.3	−1.9	1.0	3.1
19	18	Ethylbenzene	11.76	11.11	11,759 mp	11,111 mp	5.8	25.2	3.4	4.1
20	19	Carbon dioxide[g]	10.69	10.88	5,347 tt	5,439 tt	−1.7	5.2	1.1	3.2
21	23	Methanol	10.54	8.08	10,544 mp	8,084 mp	30.4	-7.1	5.3	2.8
22	21	Styrene	10.07	9.00	10,066 mp	9,001 mp	11.8	10.9	2.3	4.0
23	29	Terephthalic acid[h]	7.84	5.64	7,839 mp	5,638 mp	39.0	−26.2	−5.2	3.4
24	22	Formaldehyde[i]	7.61	8.28	7,605 mp	8,280 mp	−8.1	25.2	3.9	3.4
25	25	Xylene	6.84	6.39	949 mg	888 mg	6.9	1.2	4.5	2.7
26	24	Hydrochloric acid	6.45	7.13	3,224 tt	3,566 tt	−9.6	8.0	4.1	2.9
27	27	Toluene[j]	6.38	5.81	880 mg	801 mg	9.8	−7.7	0.1	1.2
28	28	*p*-Xylene	5.76	5.66	5,757 mp	5,656 mp	1.8	5.7	0.6	3.4
29	26	Ethylene oxide	5.68	5.83	5,684 mp	5,830 mp	−2.5	11.1	−0.9	0.3
30	30	Ethylene glycol	5.23	5.13	5,230 mp	5,129 mp	2.0	6.6	−1.1	1.7
31	31	Ammonium sulfate	4.80	4.78	2,398 tt	2,391 tt	0.3	6.6	0.6	2.1
32	32	Cumene	4.49	4.67	4,489 mp	4,666 mp	−3.8	12.0	0.2	3.0
33	34	Phenol[k]	3.72	3.61	3,718 mp	3,607 mp	3.1	0.2	0.9	3.5
34	35	Acetic acid	3.66	3.59	3,656 mp	3,594 mp	1.7	−0.6	3.0	2.7
35	33	Potash[l]	3.31	3.86	1,500 tmt	1,750 tmt	−14.3	0.1	−0.3	0.5
36	37	Carbon black	3.22	3.02	3,224 mp	3,016 mp	6.9	10.8	2.0	2.6
37	36	Butadiene[m]	3.09	3.23	3,094 mp	3,233 mp	−4.3	5.8	−0.5	2.8
38	40	Vinyl acetate	2.83	2.66	2,827 mp	2,657 mp	6.4	−2.7	2.0	3.7
39	39	Propylene oxide	2.73	2.70	2,727 mp	2,700 mp	1.0	8.0	−2.6	3.9
40	41	Titanium dioxide	2.56	2.51	1,280 tt	1,253 tt	2.2	14.4	4.6	5.4
41	38	Acrylonitrile	2.51	2.83	2,509 mp	2,829 mp	−11.3	6.8	−0.8	1.6
42	42	Acetone	2.46	2.43	2,463 mp	2,434 mp	1.2	3.7	1.4	2.9
43	44	Aluminum sulfate	2.23	2.09	1,113 tt	1,047 tt	6.3	−11.6	−2.0	0.1
44	43	Cyclohexane	2.00	2.24	2,000 mp	2,242 mp	−10.8	−2.9	−2.7	1.9
45	45	Sodium silicate	1.97	1.82	983 tt	912 tt	7.8	4.8	3.9	3.0
46	46	Adipic acid	1.56	1.56	1,560 mp	1,560 mp	0	1.0	−0.5	2.0
47	47	Sodium sulfate[n]	1.44	1.52	718 tt	761 tt	−5.7	−4.2	−2.6	−1.7
48	48	Calcium chloride[o]	1.40	1.39	700 tt	694 tt	0.8	7.9	−0.9	−2.0
49	49	Caprolactam	1.36	1.38	1,358 mp	1,378 mp	−1.4	7.4	1.5	3.3
50	—	*n*-Butyl alcohol	1.33	1.26	1,327 mp	1,263 mp	5.1	−3.9	−6.5	4.8
TOTAL ORGANICS			256.81	234.03			9.7%	4.8%	3.3%	4.5%
TOTAL INORGANICS			427.95	431.18			−0.7%	5.6%	1.6%	2.5%
GRAND TOTAL			684.76	665.21			2.9%	5.3%	2.3%	3.2%

a Revised. b tt = thousands of tons, bcf = billions of cubic feet, mp = millions of pounds, mg = millions of gallons, tmt = thousands of metric tons. c Except refractory dolomite. d Natural and synthetic. e Original solution. f 100% basis. g Liquid and solid only. h Includes both acid and ester without double counting. i 37% by weight. j All grades. k Synthetic only. l K_2O basis. m Rubber grade. n High and low purity. o 75% basis, solid and liquid.

Top 50 chemicals production grew to 685 billion lb in 1993



have boosted the industry's output even further.

Bruce Pickover, vice president of industry consultant Chem Systems, Tarrytown, N.Y., notes that weak crude oil and petrochemical prices put constraints on production in 1993. Producers drew down inventories instead of increasing production to meet demand, he says, "further affecting production." But while he agrees that chemical exports were not strong in 1993, he believes that in the long term U.S. chemical exports will recover. Not much new capacity for bulk chemical production is being built worldwide, says Pickover, and he expects to see increases in overseas demand for U.S. chemical products.

Looking to 1994, Pickover says that a continuing increase in domestic demand for chemicals on the Top 50 list will help improve the industry's use of its operating capacity. While he estimates the average operating rate for the Top 50 chemicals in 1993 was 84% of capacity, he says he would estimate that rate currently at 86%. Operating rates for bulk chemicals are up now for the first time in several years, he says.

CMA's Lenz points out that in 1994 consumer confidence is continuing to grow, vehicle sales are continuing to rise, and construction spending is still increasing, as are sales of new homes. But he is wary of recent consumer interest rate increases and their potential to put a damper on automotive and construction markets. He nevertheless predicts that U.S. gross domestic product will grow 3% in 1994 above 1993, and along with it, he expects U.S. chemical production to increase 3 to 4% in 1994.

DuPont's Stuckey thinks that recent declines in the U.S. bond and equity markets will "make households feel poorer." Where people may have planned to cash in on gains of the past year and redeem securities to purchase furniture or appliances, they may be reluctant now to do so, he says. Rising interest rates, too, will hurt consumer markets in 1994, though industrial markets may not experience the same effect and could continue to expand. Overall, says Stuckey, 1994 will see chemical output increase faster than last year's 3% pace. Help from exports, though, will depend on "the timing and pace of a European [economic] recovery," he says.

In C&EN's compilation of the Top 50 chemicals, sulfuric acid remained the largest volume chemical produced in the U.S., as it has been for many years, far outpacing any other chemical product. Output in 1993 was 80 billion lb, down 11% from the year before. In 1992, sulfuric acid production rose nearly 4% from 1991 to 90 billion lb.

Nitrogen remained a distant second, both in 1993 and 1992. Production of nitrogen rose nearly 8% in 1993 over the previous year to 65 billion lb. In 1992, nitrogen production was up 10% from a year earlier to nearly 61 billion lb.

Of the Top 50 chemicals, 29 were organic chemicals, accounting for some 38% of total production, compared with 35% in 1992. Combined organics production increased nearly 10% in 1993 from the previous year, after a more modest increase of about 5% in 1992. Over the five-year period from 1988 to 1993, combined production of organic chemicals among the Top 50 increased an average of 3% per year. Over the decade from 1983 to 1993, however, their output grew at a faster pace, close to 5% per year.

Much of the growth in the organics group came from a more than twofold production increase of methyl *tert*-butyl ether (MTBE) to 24 billion lb in 1993, as increasing amounts of the fuel oxygenate were used to meet Clean Air Act requirements. The growing use of the compound boosted it from 19th in the 1992 listing to ninth last year.

Indeed, 19 of the 29 organics posted production increases in 1993. Besides MTBE's big increase, production of terephthalic acid grew at a double-digit pace—up 39% to nearly 8 billion lb—as demand for polyester film and resins grew. Its strong growth moved it to 23rd place among the Top 50 from 29th place in 1992. Terephthalic acid production had declined 26% in 1992 to about 6 billion lb.

Methanol production also grew rapidly, up 30% in 1993 to about 11 billion lb, placing it 21st on the list. In 1992, methanol production dropped 7% from 1991 to 8 billion lb, ranking it 23rd among the Top 50. Vinyl chloride production rose 22% in 1993 to nearly 14 billion lb, placing it 17th on the list, down from 16th place in 1992, when output was closer to 11 billion lb, a 3% decline from 1991.

Also showing double-digit increases in 1993 production were ethylene dichloride and styrene. Ethylene dichloride production rose about 19% in 1993

to 18 billion lb, placing it 13th on the list. In 1992, it ranked 15th, with output at 15 billion lb, up 11% from the previous year. Styrene production rose 12% in 1993 to 10 billion lb, placing it 22nd on the list. In 1992, styrene output increased 11% to 9 billion lb, and it was ranked 21st in the Top 50.

Whereas overall organic production grew in 1993, overall production of inorganic chemicals among the Top 50 did not. Combined output of the 21 inorganic chemicals decreased almost 1% from the previous year, following a nearly 6% increase in 1992. Over the five-year period from 1988 to 1993, combined output of inorganic chemicals grew at an average annual rate of about 2% per year. Over the most recent decade, production of inorganics grew at a little closer to 3% per year.

Of the inorganics, 13 of the 21 posted production increases, led by second-place nitrogen, with its 8% increase to 65 billion lb. Sodium silicate also had a good year, with output also up 8% to nearly 2 billion lb. However, it continues to occupy the same 45th ranking it held in the 1992 Top 50.

The 1993 Top 50 listing contains one new addition: *n*-butyl alcohol. It displaces isobutylene on the 1992 list. □

Output of polymers increased almost 3%

Overall U.S. production of commercial polymers, including plastics, synthetic fibers, and synthetic rubber, edged up nearly 3% in 1993 from 1992. As a result, production reached a new high last year: 67.4 billion lb. However, output growth was stronger in 1992, when polymer production rose 5% over the previous year and totaled nearly 66 billion lb.

Of the three groups of polymers surveyed, plastics production accounts for more than three quarters of total polymer production. Plastics also led overall polymer growth in 1993, with a nearly 3% production rise to 53 billion lb. Synthetic fibers production increased close to 3% to just over 9 billion lb, but synthetic rubber output declined nearly 2% to about 5 billion lb.

Production of thermosetting resins grew at a fairly impressive rate of more than 8% to 6.9 billion lb, following more than 7% growth in 1992. Thermoplastic resins production, however, rose only 2% in 1993 to slightly more than 46 billion lb. This came after a nearly 5% increase in 1992.

Among thermosetting plastics, output of melamine resins grew at an annual rate of more than 16% in 1993, following an 18% increase in 1992. Urea resins turned in the next best performance, up nearly 13% in 1993, compared with a much slower 4% increase in 1992. Production of unmodified epoxy resins also showed double-digit growth in 1993, up nearly 12%, compared with an 8% decline a year earlier. Unsaturated polyester resins registered a nearly 8% increase in 1993, after a more than 9% increase in 1992. Phenol and other tar acid resins showed a modest but still respectable 5% production increase in 1993, following a 10% increase in 1992.

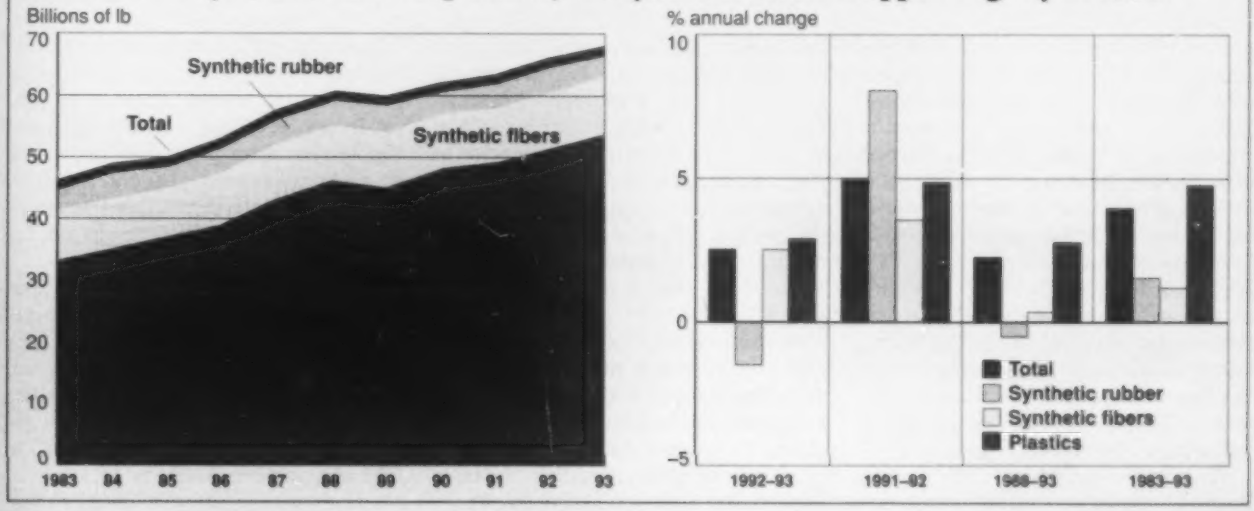
In the thermoplastic resins category, polystyrene registered the best production increase in 1993, up 5%, following an almost 3% increase in 1992. The next best performer was the polyvinyl chloride and copolymers category, up almost 3% in 1993, after a nearly 9% production increase in 1992. Polypropylene production rose only 2% in 1993, after it edged up 1% in 1992. Both low-density and high-density polyethylene production increased a modest 1% in 1993. Production of the low-density resin grew nearly 3% in 1992, and that of the high-density resin grew more than 6% in 1992.

Synthetic fiber output continued its slow but steady rise. Total output reached 9.3 billion lb in 1993, up nearly 3%, a little slower than the 4% rate in 1992.

Cellulosic fiber production continued to rise about 2% in 1993 as well as 1992. Manufacture of both rayon and acetate fiber produce much waste. Over the past 10 years, heavy environmental pressure has forced cellulosic fiber production down an average 2% per year. However, the production rise in 1992 and 1993 reflects continued demand for the fibers in fashion apparel.

Although the production of noncellulosic fibers has its own environmental pitfalls, these are not so great as they are with cellulosic fibers. Noncellulosic fibers are also more widely used because they are easier to produce and process in knitting and weaving machines.

Plastics and synthetic fiber output rose, but synthetic rubber slipped slightly in 1993



Total polymer production exceeded 67 billion lb in 1993

	Billions of lb		Common units				Average annual growth			
	1993	1992	1993	1992	1988	1983	1992–93	1991–92	1988–93	1983–93
PLASTICS (common units = millions of lb)										
Thermosetting resins[a]	**6.87**	**6.34**	**6,866**	**6,335**	**6,588**	**5,254**	**8.4%**	**7.2%**	**0.8%**	**2.7%**
Phenol and other tar acid resins	3.08	2.92	3,078	2,923	3,066	2,484	5.3	10.0	0.1	2.2
Urea resins	1.74	1.55	1,744	1,548	1,425	1,172	12.7	4.4	4.1	4.1
Polyesters (unsaturated)	1.26	1.18	1,264	1,175	1,404	1,084	7.6	9.3	−2.1	1.5
Epoxies (unmodified)	0.51	0.46	510	457	486	334	11.6	−8.0	1.0	4.3
Melamine resins	0.27	0.23	270	232	207	180	16.4	18.4	5.5	4.1
Thermoplastic resins[a]	**46.19**	**45.23**	**46,194**	**45,231**	**39,608**	**27,799**	**2.1%**	**4.6%**	**3.1%**	**5.2%**
Low-density polyethylene	12.04	11.92	12,044	11,917	10,397	8,041	1.1	2.9	3.0	4.1
PVC and copolymers	10.26	9.99	10,257	9,989	8,350	6,066	2.7	9.0	4.2	5.4
High-density polyethylene	9.91	9.81	9,912	9,808	8,400	5,691	1.1	6.4	3.4	5.7
Polystyrene[b]	5.37	5.10	5,367	5,096	5,187	3,567	5.3	2.9	0.7	4.2
Polypropylene	8.61	8.42	8,614	8,421	7,274	4,434	2.3	1.1	3.4	6.9
TOTAL[a]	**53.06**	**51.57**	**53,060**	**51,566**	**46,196**	**33,053**	**2.9%**	**4.9%**	**2.8%**	**4.8%**
SYNTHETIC FIBERS (common units = millions of lb)										
Cellulosics[a]	**0.51**	**0.50**	**505**	**495**	**614**	**640**	**2.0%**	**1.9%**	**−3.8%**	**−2.3%**
Rayon[c]	0.28	0.28	278	275	400	411	1.1	0.7	−7.0	−3.8
Acetate[d]	0.23	0.22	227	220	214	229	3.2	3.3	1.2	−0.1
Noncellulosics[a]	**8.79**	**8.57**	**8,792**	**8,573**	**8,526**	**7,534**	**2.6%**	**3.7%**	**0.6%**	**1.6%**
Polyester	3.56	3.58	3,557	3,576	3,680	3,543	−0.5	4.8	−0.7	0
Nylon	2.66	2.56	2,664	2,556	2,670	2,418	4.2	0.8	0	1.0
Olefin[e]	2.14	2.00	2,138	2,002	1,588	902	6.8	7.3	6.1	9.0
Acrylic[f]	0.43	0.44	433	439	588	671	−1.4	−3.3	−5.9	−4.3
TOTAL[a]	**9.30**	**9.07**	**9,297**	**9,068**	**9,140**	**8,174**	**2.5%**	**3.6%**	**0.3%**	**1.3%**
SYNTHETIC RUBBER (common units = thousands of metric tons)										
Styrene-butadiene[g]	1.89	1.92	855	871	909	904	−1.8	3.3	−1.2	−0.6
Polybutadiene	1.03	1.02	465	461	407	333	0.9	11.1	2.7	3.4
Ethylene-propylene	0.58	0.58	261	265	263	175	−1.5	14.2	−0.2	4.1
Nitrile	0.14	0.13	64	59	76	55	8.5	3.5	−3.4	1.5
Other[h]	1.37	1.42	621	644	679	468	−3.6	10.8	−1.8	2.9
TOTAL[a]	**5.00**	**5.07**	**2,266**	**2,300**	**2,334**	**1,935**	**−1.5%**	**8.1%**	**−0.6%**	**1.8%**
GRAND TOTAL ALL POLYMERS	67.35	65.71					2.5%	5.0%	2.2%	4.0%

a: Totals are for those products listed and may not add because of rounding. b: No longer includes acrylonitrile-butadiene-styrene or styrene acrylonitrile resins; historical data are restated. c: Includes acetate tow beginning with 1985. d: Includes diacetate and triacetate yarn but does not include cigarette tow. Beginning with 1985, includes rayon yarn. e: Includes olefin film, olefin fiber, spun-bonded polypropylene and vinyon. f: Includes modacrylic. g: Includes high-styrene latex. h: Beginning with 1985, includes neoprene; historical data are restated. Also includes butyl, polyisoprene, chlorosulfonated polyethylene, polyisobutylene, and acrylic, fluoro, and silicone elastomers. **Sources:** Society of the Plastics Industry; Fiber Economics Bureau; Rubber Manufacturers Association; International Institute of Synthetic Rubber Producers

Noncellulosic fiber output increased nearly 3% in 1993, after a nearly 4% rise in 1992. Olefin and nylon fibers both benefitted as the housing market continued to expand in 1993 and carpeting demand rose. Olefin grew fastest, up nearly 7% in 1993, following a more than 7% rise in 1992. Olefin is seeing increasing use in area rugs and other floor coverings. Nylon production rose 4% in 1993, following an almost 1% increase in 1992. Polyester fiber output declined about 1%, after a nearly 5% rise in 1992. Acrylic fiber output continued its 10-year downward spiral, with production off more than 1% in 1993, following a 3% decline in 1992.

This year's polymers data include synthetic rubber production, which was not available for last year's compilation of production figures (C&EN, April 12, 1993, page 16). Synthetic rubber production slipped about 2% in 1993 to 5 billion lb, following a more than 8% increase in 1992. Nitrile rubber recorded the headiest growth of the group, with output up nearly 9% in 1993, following an almost 4% rise in 1992. Polybutadiene grew about 1% in 1993, after a much higher 11% growth rate in 1992.

Production of the three remaining categories of synthetic rubber declined in 1993. Both styrene-butadiene and ethylene-propylene elastomer production fell almost 2% in 1993. And production of a miscellaneous group, including neoprene, butyl, and polyisoprene, fell nearly 4%.

Last year, the International Institute of Synthetic Rubber Producers (IISRP) was unable to provide the breakout of U.S. production data that it had in the past. The government had halted its rubber production survey in 1990, and the Rubber Manufacturers Association discontinued the publication of its U.S. data at the same time.

An IISRP spokesman says that this year the group's internal reporting regulations allow it to again break out U.S. synthetic rubber production data for 1993 and previous years. Once again, the table and graphs accompanying this article include rubber production data for 1993 and previous years.

Marc Reisch

European chemical sales, earnings better than expected in 1993

Patricia L. Layman, C&EN London

Most sectors of the European chemical industry—petrochemicals being the notable exception—performed better last year than had been widely forecast at the beginning of the year, according to 1993 financial results just posted by chemical producers there.

What's more, the outlook for 1994 is even better. Progress may be slow, producers agree, and some trouble spots remain. However, producers are feeling less depressed as they see European economies beginning to stir from their doldrums, with demand picking up and overcapacity declining. That's especially encouraging because the European share of these companies' sales have declined more steeply than those overall.

Moreover, the recent price decrease for oil and its derivatives is helping chemical producers boost woefully low operating margins.

The rapid drop in oil prices is complicating chemical executives' plans and models for running their businesses. For example, as recently as early February, Brian K. Sanderson, chief executive of BP Chemicals, a subsidiary of British Petroleum, noted that the company is well on its way to meeting targets that were set expecting $18-per-barrel oil prices. "Now we are figuring at $16, with alternative plans for what to do at $14 per barrel."

In addition, as demand begins picking up, price increases are starting to hold, boosting profit margins as well. "One can't make too much of this," says Tony Cox, chemicals analyst with Kleinwort Benson, securities brokers in London, "but there may be some change of psychology in purchasing agents" that is allowing prices to firm. Customers will expect some pass-along of declining raw materials prices, he says, but "it will be possible for producers to widen their margins by not giving away all the benefits" of the oil price drop. He points to similarities with the oil price collapse in 1986, which coincided with the beginning of an earlier recovery of the chemical industry.

Such improvements can't come too soon for the European chemical industry. For example, at Dutch producer DSM, which posted a net loss in 1993—a result chairman Simon De Bree characterized as "downright poor"—average selling prices were almost 7% lower last year. The company's operating results for 1993 fell dramatically, mainly because of lower profit margins for virtually all products.

Indeed, for 1993, operating and profit margins remained troublesome throughout Europe. In their efforts to cope, many chemical companies have intensified restructuring efforts over the past year, shedding employees, closing plants, and selling operations, among other actions.

As Sir Denys Henderson, chairman of British producer ICI, puts it, "The results for 1993 are relatively encouraging in the context of a difficult global marketplace. With overall sales volumes virtually flat and prices under pressure, the improvement in profits [for ICI] from continuing operations essentially came from cost reductions and currency."

Restructuring costs hit commodity chemical companies especially hard. For example, France's Elf Aquitaine took a special provision of $68 million in the second half of 1993 for reorganizing its chemicals sector.

Similarly, at Total, also of France, where operating earnings from chemicals declined 14% from 1992, the company could find solace only in that the earnings performance could have been worse. "This result shows the segment's resistance to the recession, which hurt the main European specialty chemicals markets," says a Total executive. Resistance was helped in part, the company adds, by the sustained implementation of rationalization programs.

The chemical arm of Royal Dutch/Shell posted operating losses for the year of $604 million, compared with losses of $329 million in 1992. However, the company says, the 1993 loss included $496 million for restructuring—compared with only $95 million total for restructuring in 1991–92. Excluding special items, results for the year improved, benefiting from lower feedstock prices and cost reductions, the company says. And by the fourth quarter, the improvement was clear: a loss of $100 million, compared with a loss of $269 million in fourth-quarter 1992.

However, stringent cost-cutting programs have begun to pay off. In the Nordic countries, where economies have been particularly hard hit, Finland's Kemira points to the initial benefits in its operating performance from the major rationalization program it has undergone. The company pulled a pretax loss of nearly $60 million in 1992 into the black, with pretax profits of $5 million last year.

Similarly, at Norsk Hydro, of Norway, extensive restructuring steps taken in the agriculture division—essentially fertilizers—meant that the division showed a small operating profit for the year, following serious losses in both 1991 and 1992. Cuts in costs in agri-

European companies reported mixed financial results in 1993

	Sales	Net earnings	% change from 1992 Sales	% change from 1992 Net earnings
	($ Millions)			
CHEMICAL COMPANIES				
Hoechst (Germany)	$26,560	$ 436	0.3%	−36%
BASF (Germany)	24,873	495	−3	88
Bayer (Germany)	23,653	765	−0.4	−13
Rhône-Poulenc (France)	13,680	313	−1	−16
ICI (U.K.)	12,449	204	12	def
Akzo (Netherlands)	8,322	277	−1	−15
Solvay (Belgium)	6,683	−194	−5	def
DSM (Netherlands)	4,054	−59	−10	def
Kemira (Finland)	2,046	5[a]	6	na
Laporte (U.K.)	1,319	56	47	30
Dyno (Norway)	1,096	41[a]	10	92
Lonza (Switzerland)	575	26	4	5
PHARMACEUTICAL COMPANIES				
Ciba (Switzerland)	15,307	1,202	2	17
Sandoz (Switzerland)	10,206	1,153	5	14
Zeneca (U.K.)	6,557	650	12	na
Schering (Germany)	3,093	147	2	−3

a Pretax. def = deficit. na = not available.

Oil and diversified firms awash in red ink last year

($ Millions)	Total sales	CHEMICAL OPERATIONS		% change from 1992	
		Sales	Operating earnings	Sales	Operating earnings
OIL & DIVERSIFIED COMPANIES					
Royal Dutch/Shell (U.K., Netherlands)	$93,555	$9,304	$-604	12%	def
Elf Aquitaine (France)	35,605	8,490	-31	0	def
Veba (Germany)	39,242	5,826	-199	-1	def
Henkel (Germany)	7,999	4,599	na	1	—
British Petroleum (U.K.)	51,614	4,333	-102	-1	def
Norsk Hydro (Norway)	8,309	4,217	115	7	1,019%
Unilever (U.K., Netherlands)	41,148	3,456	409	19	15
Total (France)	23,005	3,124	244	-2	-14

def = deficit, **na** = not available.

culture, coupled with improved performance in the company's petrochemicals division—which just dipped into the red in 1992—gave the company its dramatic increase in operating profits for 1993.

But restructuring had negative effects on at least one specialties company—Henkel, the German chemicals and detergents producer. It directly attributes its 1993 profits decline to restructuring, as the company trimmed its work force by 2,000 through the year. It says the benefits of the cost-cutting will be reflected in this year's results.

However, although the economy is improving, the benefits will not be experienced this year throughout the European industry. At German oil company Veba, for example, officials say the chemicals division—essentially Hüls—will continue to shed jobs over the year; no profit for the division is expected until next year.

Still unquestionably troubling the industry is the problem of overcapacity and low profit margins for petrochemicals and other commodities. An industrywide capacity reduction program, sponsored by the Brussels-based Association of Petrochemicals Producers in Europe, fell by the wayside late last year, so companies have been faced with taking unilateral action, if any, to reduce capacity.

At the beginning of this year, BP Chemicals closed its ethylene cracker at Baglan Bay in Wales. "Further industry restructuring is needed, but our remaining petrochemical assets are among the most efficient in Europe," says Sanderson. "It was a painful restructuring for BP, but it was certainly the right thing for us to do. We would have preferred, of course, to have it part of a European industrywide restructuring. That will still have to be done, eventually.

"It was a tough year, really," he adds. The operating loss of $102 million carried over from an operating loss of $35 million the year before, because "historically low petrochemicals margins in Europe" were only partly offset by productivity improvements, cost savings, and favorable exchange rate movements. A higher level of restructuring costs also added to the operating losses.

BP Chemicals' cracker closure was a lonesome action. Tony Church, chemicals analyst with London stockbrokers Wertheim Schroder & Co., points out, "There has been no significant change in the amount of capacity that will be available in Europe over the next two or three years. Taken together with the ongoing effects of the European recession, we believe that the failure to reduce capacity ensures that restoring margins when the economic upturn does occur is going to be very difficult."

Moreover, he adds, "Our latest information is that, although the climate is changing to a greater acceptance by customers of higher feedstock costs, large price rises by chemical producers seem unlikely against continuing oversupply."

However, the picture is slowly becoming clearer and brighter. For instance, at the press conferences held last month to reveal 1993 annual results, executives for Germany's big three chemical firms—Hoechst, BASF, and Bayer—were all optimistic, even though the German economy is still among the most depressed among European countries.

Normally, the yearly spring press conferences for the three companies are solemn two-hour question-and-answer marathons. This year, however, Manfred Schneider, chairman of Bayer, for example, was in good enough spirits to pepper his press conference with puns and jokes. But then, improved conditions gave him some justification. Pessimistic predictions a year ago about severe earnings drops did not come to pass, except in Europe, where Bayer's operating earnings dropped 31%. Growth elsewhere—in North America, for example—cushioned the impact, limiting the company's total fall in profits.

More encouraging, however, was that "the fourth quarter of 1993 was better than anticipated, and sales in January and February 1994 rose by more than 6%," to nearly $4.12 billion, according to Schneider.

Two months do not make a full year, of course, and company executives have been cautious about extrapolating corporate results for 1994 based on January and February, and possibly a strengthened fourth quarter of 1993. Many are now agreeing, however, that things are picking up.

"Chemicals outperform the market at the bottom of cycles and in the first year of the recovery in the cycle," observes Kleinwort Benson's Cox. "We are looking for anything from a 10 to 40% increase in chemical profits this year—but that is from a very low base. Earnings as an absolute value won't be satisfactory, but it will be solid growth." □

Sales poor in Europe for chemical companies

	% change from 1992	
	Total sales	European sales
CHEMICAL COMPANIES		
Hoechst (Germany)	0.3%	-9%
BASF (Germany)	-3	-8
Bayer (Germany)	-0.4	-10
Rhône-Poulenc (France)	-1	-9
ICI (U.K.)	12	-6
Akzo (Netherlands)	-1	-7
DSM (Netherlands)	-10	-11
Laporte (U.K.)	47	72
PHARMACEUTICAL COMPANIES		
Ciba (Switzerland)	2	-4
Zeneca (U.K.)	12	-1
DIVERSIFIED & OIL COMPANIES		
Shell (U.K., Netherlands)	12[a]	-2[a]
Henkel (Germany)	1[a]	-7[a]

a Chemical sales.

Firings, Outlook Worse For Long-Time Workers

The Subcommittee on Professional Standards & Ethics of the former ACS Committee on Professional Relations' (CPR) latest report on multiple terminations gives details of six such terminations that occurred between April 1991 and January 1993. These terminations involved 56 job losses by chemical professionals.

CPR went out of business at the end of 1993 when it and the ACS Committee on Economic Status were merged into the Council Committee on Economic & Professional Affairs (CEPA).

The report, the 37th in a series dating back to 1974, indicates that an additional five multiple terminations have been verified and 21 as yet unverified reports are currently under investigation.

A multiple termination, as defined by CPR guidelines, is a situation in which the employment of three or more chemical professionals is terminated by a single employer within a six-month period for reasons other than continuing evidence of previously documented inadequate performance, completion of a contract, or cause.

The reports have always been concerned only with job losses that are clearly involuntary. They do not provide a mechanism for investigating the "voluntary" separations and early retirement programs that have pervaded the chemical and related industries in recent times. Thus, the reports may not accurately reflect the employment picture for some chemical professionals.

There have also been numerous problems gathering information from terminees and from employers. For these and other reasons, CEPA voted to phase out this multiple termination program at the end of 1994. The committee will, however, complete pending investigations and monitor and publish employment information via other means.

The six multiple terminations detailed in the latest report were at Aluminum Co. of America (Alcoa), Amoco Petroleum Additives, Ethyl Corp., Georgia-Pacific, Koch Protective Treatment Inc., and S.C. Johnson Wax. The largest was at Ethyl, with 21 confirmed involuntary separations; the smallest was at Koch, with three.

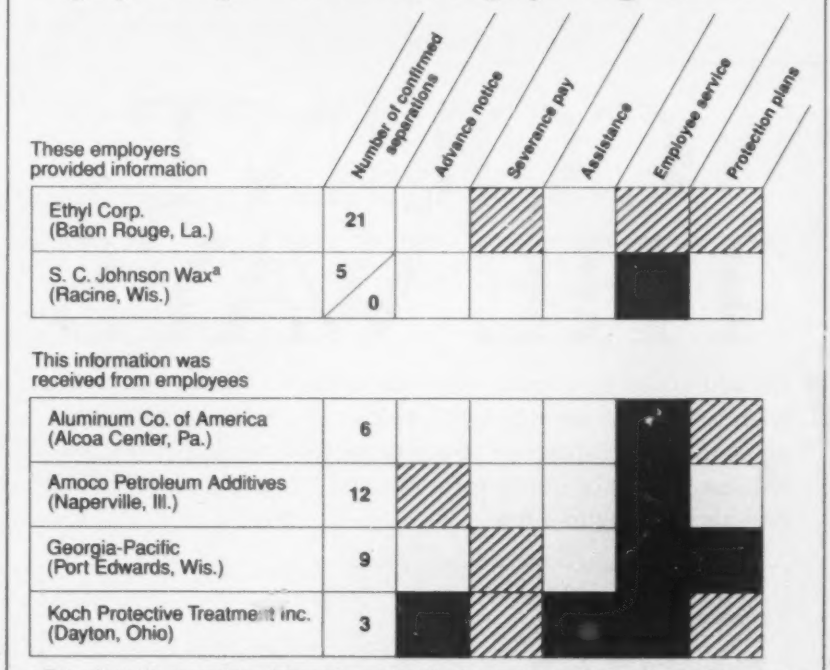
The five verified multiple terminations on which CEPA investigations are not yet complete were at Miles Diagnostic, Koch, A. D. Little, Dow Chemical, and UOP.

As is customary, the latest report compares the performance of employers with standards spelled out in ACS's Professional Employment Guidelines (PEG). These guidelines are concerned with advance notice, severance pay, assistance in finding new employment, length of employee service, and employee protection after termination.

Overall compliance with the PEG standards has remained fairly constant over the years. For the first 19 reports, through mid-1984, compliance was 42%; since then, it has been 44%. For this report, it was 42%.

The most discouraging news comes in the drop in compliance in meeting employee service standards. PEG standards call for no terminations of employees who have 10 years' or more service. For the first 19 reports, compliance was 26%; since then, it has dropped to 13%. No employers in the current report complied with standards in this category. About 60% of all terminees in the current report appear to have had more than 10 years of service; among these, the average length of service was 21 years.

Employer compliance with ACS employment guidelines



a This reflects the contradictory information provided by the company and the employees. The company reported no involuntary terminations; five employees reported they were involuntarily terminated.

- ☐ Employer met or exceeded guideline standard.
- ▨ Two or more individuals below guideline standard, but average experience better than "substantially below" criterion.
- ■ Employer was substantially below guideline standard, which is defined as follows:
  - Advance notice—less than four weeks.
  - Severance pay—less than two weeks per year of service.
  - Assistance—no assistance rendered.
  - Employee service—more than 30% of terminees had 10 or more years of service.
  - Protection plans—no continuation of protection plans.

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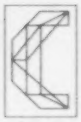

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- **Advance notice. Four-week minimum.**
- **Severance pay. Minimum is two weeks per year of service. Additional notice may be given, by mutual agreement, in lieu of severance pay.**
- **Assistance. Efforts should be made to place terminee in another position within the organization, or terminee should be given assistance to find employment elsewhere.**
- **Employee service. Those with minimum of 10 years' service should not be terminated except for continued evidence of previously documented inadequate performance or cause.**
- **Employee protection plans. Should be extended for a minimum of one month, plus two weeks for each year of employee service, following termination, at same rate of contribution as before. Employee would have additional 31-day grace period.**

These data were somewhat offset by evidence of improvement in meeting the severance pay standard of two weeks' pay for each year of service. For the first 19 reports, only 16% of employers complied. For the second 18, compliance was 42%. This report indicated 50% compliance.

Also showing improvement was compliance with PEG standards that call for four weeks' advance notice of termination. In the latest report, four of six employers—Ethyl, S.C. Johnson Wax, Alcoa, and Georgia-Pacific—complied with this standard. One, Amoco Petroleum Additives, fell below guidelines. Koch fell substantially below guidelines. Throughout the years, compliance with this standard has remained steady at about 40%.

Compliance with the employee assistance standard has improved throughout the years, dropping only slightly to 83% for this report. The first 19 reports indicated 65% compliance; since then, compliance has risen to 86%. In the current report, only Koch failed to offer terminees résumé preparation and other services.

The PEG standard on protection plans calls for continuation of health insurance at employer expense for at least one month beyond separation. Compliance,

48% over the past 20 years, has declined over the past 10 years to 34%. The figure for the current report is 33%. Under the Consolidated Omnibus Budget Reconciliation Act of 1985, however, a terminee is entitled to continuation of benefits for up to 18 months. This may be the primary reason that employers appear to be falling short on meeting this guideline.

Chemical professionals who have been fired or have taken early retirement are requested to contact the American Chemical Society, Office of Professional Services, 1155—16th St., N.W., Washington, D.C. 20036. Copies of all multiple termination reports and related C&EN stories are available, on request, from the same office.

Linda Ross

Lehigh Valley Section's 100th anniversary

The ACS Lehigh Valley Section celebrated its 100th anniversary last month. A full-day program in Bethlehem, Pa., included the dedication of Lehigh University's William H. Chandler Chemistry Laboratory as the second ACS National Historic Chemical Landmark, two centennial lectures, and a dinner dance.

The section was launched a century ago when 15 chemists gathered at the Chandler Lab. The goals of the new section were to advance chemical science and to improve science education in the Lehigh Valley area. Today, the section's membership includes nearly 1,000 chemists, chemical engineers, and educators. Members are drawn from 97 local companies, 11 area colleges and universities, and seven high schools.

As part of the anniversary program, centennial lectures were given by Lehigh University professor emeritus Roland W. Lovejoy, and chemistry department chairman Kamil Klier. The lectures highlighted the development of infrared and photoelectron spectroscopy. Afterward, local industrial representatives displayed exhibits highlighting their progress during the past century.

Later, more than 150 members of the section gathered to celebrate and to hear ACS president and Lehigh University professor Ned D. Heindel deliver the Centennial Address, "Showcasing Chemistry: The ACS Smithsonian Exhibit." During the program, section chairman Andrew Gilicinski presented Heindel with the section's 1994 Service Award, its highest honor.

Photo by J. H. Larch, Air Products

Gilicinski (left) and McHale at centennial celebration.

Attila Pavlath, ACS director-at-large, was on hand to present special certificates to all past chairmen in attendance. Fifty-year section members were also recognized. Attendees included Rep. Paul McHale (D.-Pa.), ACS executive director John K Crum, and ACS Board chairman Paul H. L. Walter. □

Vacancies to be filled

Two vacancies have been created on the ACS Council Committee on Nominations & Elections (CN&E) by the recent resignations of Stanley H. Pine, who resigned to accept an appointment to the Society Committee on Education, and Henry F. Whalen Jr., who resigned to become a candidate for director-at-large this fall. A special election will be conducted by mail ballot among ACS councilors to fill the vacancies. The Council Policy Committee has selected Warren V. Bush, George E. Heinze, Alvin L. Kwiram, and Kathleen Trahanovsky as candidates.

Other candidates may be nominated by petition; signatures of at least 25 councilors are required for a valid petition, and petitions must be received by the ACS executive director by May 31. Ballots will be mailed to councilors in time to have the new CN&E members seated at the fall meeting in Washington, D.C. In accordance with ACS bylaws, the successful candidates will serve the remainder of the terms of Pine and Whalen.

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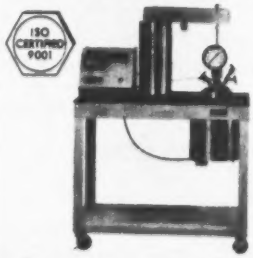

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